THE PSYCHOLOGY OF REFLEX ACTION

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I. *The Problem of Reflex Action.* Extremely anomalous is the position of reflex action in the domain of psychology. At least psychologists seem to be doubtful concerning the orientation of such behavior in the general psychological field and hesitant as to the exact attitude they should take toward reflex action. Traditionally, psychologists have been able to grant no more than that reflexes are exclusively physiological processes, because psychologists have always considered knowing as the essential datum of their science. To accommodate the fact that reflex action actually constitutes a part of the response equipment of organisms, as the biological influence upon psychology made apparent, reflexes, though not considered to be psychological phenomena, were tolerated as the motor accompaniments or the motor conditions of mental states.

In recent years a number of important conditions have conspired to bring about essential modifications in our attitudes toward reflex action, and especially influential in this connection is the fostering of the conviction that reflexes play a larger part in our total adjustments than was ever before realized. Prominent also among these conditions were the discoveries concerning the conditioning of reflexes. So recent have been these discoveries that at the present moment, lacking the necessary perspective, we are unable to realize precisely how great the changes are which they have effected in the domain of psychology, although it is apparent of course to everyone that important changes have taken place.

Another equally significant and by no means unrelated condition is the fact that psychologists in general are drifting away from the idea that a psychological datum is exclusively or even primarily a knowing fact in the sense of some psychic stuff or mental function, toward a more organic position. How great the change of front toward reflexes has been may be observed at a glance in the view now current and gaining ground that all psychological facts are based upon and developed from reflex action. Poignancy is added to this change of front when we reflect upon the great gulf which psychologists once considered to separate physiological behavior from elaborate knowing activities. As important as reflex actions undoubtedly are it

yet seems that we are going too fast and too far in our newer emphasis upon such behavior. Because there exists apparently so much uncertainty in the attitudes toward reflex action, the following study of reflexes is undertaken, with the aim of offering some suggestions toward the redefinition of these interesting and important types of behavior.

II. *Distinction Between the Psychological and Physiological Attitudes toward Reflexes.* Although, as we have endeavored to suggest in the preceding paragraph, psychologists have traditionally held themselves aloof from reflexes, because the latter were presumed to be entirely physiological, strangely enough it is owing in great part to the investigations of physiologists that the need for a closer study and understanding of reflexes by the psychologist has manifested itself.

How strange in fact it is that the physiologist's study of the conditioning of reflexes should induce the psychologist to recognize that a reflex action can and must be looked upon as a response to a stimulus, that is to say, an adjustment act, can be readily appreciated when we observe how great the differences are between the psychological and physiological attitudes toward reflex action. What is then the difference in the two attitudes? Merely this: that while according to the psychologist a reflex must be looked upon as a special adjustment of the organism as a whole, for the physiologist a reflex action is the operation of an autonomous system of particular parts of an organism. Now if this distinction is valid it is obvious that in order to reach an accurate description of reflex behavior this differentiation must be kept in mind.

Because the physiologist, while studying reflexes, is primarily interested in the functioning of neural structures, and secondarily in the activity of glands and muscles, he is disposed to look upon such behavior, as well as other types of responses which he studies, as constant mechanisms entirely independent of the surrounding stimuli. From this fact arises the distinction long current in psychological literature between the so-called physiological and sensation reflexes, the former being presumably completely autonomous and without the controlling influence of awareness. Accordingly the psychologist assumed that typical reflexes are exemplified by the visceral activities. Since on the whole, therefore, a reflex action for the physiologist consists of the innervating activity of a segmental neural apparatus, a limited extension and flexion of muscles, and the localized action of glands and nothing more, we must look upon the physiological description of a reflex action as an abstraction, wholly unsuitable for use by psychologists.

From the psychological standpoint, as we have suggested, a reflex action is a definite adaptation act and upon such a basis

is just as much a psychological datum as is thinking and knowing. Strictly speaking, the psychological organism under ordinary circumstances cannot act otherwise than as a psychological organism, and this refers to all activities, although for some purposes we might consider the individual performing isolated reactions such as merely digestion, etc. But these situations are exactly analogous to those accidental circumstances such as being struck by an automobile in which instance the individual may function as a mere physical object. To be entirely precise at this point we mean to point out that as a general principle, our exogenous reflex activities are stimulated to action by objects and events about us and operate as adaptational mechanisms in exactly the same sense as any psychological act.

In general, then, we may take as our standard for the differentiation between psychological and physiological reactions, a criterion which we verily believe to be in the main reliable, the question whether an act is or is not an organismic[1] response to stimulating circumstances. Now in order that an act should be considered a genuine organismic response we must be able to trace its arousal to some effect produced upon the person by some external object or some need for adaptation existing in the organism itself. Accordingly, as we might expect, no sharp lines of division mark off the internal from the external reflex stimuli. A food object operates precisely as does the hunger reflex (gastric contractions) in the arousal of salivary reflexes. Similarly from the standpoint of effecting an action in the person there is no functional difference between another person (opposite sex) and genital reflexes in the acting person when each serves as a type of stimulus to elicit (other) sexual reflexes. Whether the stimulus be endogenous or exogenous the reaction which it calls forth is an adaptation of the individual in just the same way that a habit or thought reaction is. On the whole, we find the reflex to be (and this is why it is a psychological act) an interconnection between organisms and specific things; or in better words, reflexes are the operation of reciprocally interacting stimuli and responses. Thus when I see a dish of apples my salivary reflexes may begin to operate, while a dish of peaches may not have the same effect at all. Now here the physiological attitude, according to which the problem of the reflex begins and ends entirely within the organism, contrasts with the psychological study in that the latter is concerned with (1) the means whereby the end-effect, which is the secretion or muscular contraction, is initiated, and (2) how the act is dependent upon the reactional characteristics of the specific individual performing the act. The psychologist cannot afford to overlook the fact

[1]The term organismic refers to the absolute inseparability of the response and stimulus factors in a psychological reaction.

that reflexes are very strictly conditioned and that upon the type of stimulus object which elicits the reaction depend the intensity and range of the behavior.

Persuasive as an argument for the organismic character of reflex action is the testimony of the physiologist himself. Asserts Sherrington, than whom no investigator is more qualified to speak in this matter, that reflexes are fractional pieces split off from an animal's total behavior which are artificially though conveniently treated apart[2], and that a simple reflex is probably a purely abstract conception, a convenient if not a probable fiction.[3] Furthermore, even the experimental physiologist finds it necessary to declare "that the reflex reaction cannot be really intelligible to the physiologist until he knows its aim."[4] And so the physiologist considers as an essential part of the investigation of reflex phenomena the eliciting of their purposes. This does not mean at all the indulgence in any factually baseless speculation, but merely involves looking upon a reflex action as a fact in its adaptational perspective. When the operation of a reflex mechanism occurs, it is necessary in the interests of a fair understanding of it, to include as many as possible of its essential features. Among such essential features we may mention the influence upon the reflex action of the location of the stimulus—the local sign of reflexes, as Sherrington calls it.

If the experimental physiologist acknowledges what we are pleased to call the definite psychological character of reflex action, certainly the psychologist may well pause to reconsider his habitual descriptions of such behavior. Let us hasten to add in unequivocal terms that to adopt the psychological standpoint of studying reflex action means not at all that our study will lose one iota of its objective character. On the contrary, such a method of study will add completeness as well as definiteness to our descriptions. In plainer words, the psychological standpoint implies that we shall look upon the reflex response as well as upon every other act that falls within our purview, as the adjustment of a psychological machine, in the sense that we shall correlate the acts of the organism with the coincidental surrounding conditions.

Is it necessary to add, in view of our discussion and our calling to witness the experimental physiologist, that there is no actual conflict between the physiologist and the psychologist? No such conflict exists in fact, since each worker is merely interested in a different phase of the same series of events. While the psychologist is interested in the total action of the person to some definite stimulus, the physiologist is interested

[2]Integrative Action of the Nervous System, 1911, 237.
[3]Ibid., 8.
[4]Ibid., 238.

in the workings of the reflex mechanism as they operate within the organism itself. What we are desirous of showing is that when the psychologist is satisfied to duplicate the work of the physiologist then he cannot hope to do justice to the psychological facts in the case.

If our distinction between psychological and physiological behavior is valid, we find in it a compelling warning not to confuse reflex behavior with the truncated activities of injured and partially destroyed organisms. All experimental animals such as the decerebrate pigeons of Flourens and Schrader, Goltz's dogs and other laboratory animals exhibit atypical forms of behavior which cannot be fairly taken as examples of reflex responses. How valid this point is will come out later in our discussion of the differences between normal responses of animals and human beings.

III. *The Nature of a Reflex Action.* From the psychological standpoint, then, we must look upon a reflex action as a specific sort of behavior segment and this means, as we have indicated, that we must not only investigate the response mechanisms but the stimulating circumstances as well. Now the special reflex characteristic of the reflex type of behavior segment is that there is only one reaction system in it. To be more specific the reflex activity, although the adjustment of a complex animal or person, is a simple and immediate final response to a directly presented stimulus. Obvious it is then that there are no precurrent or anticipatory reactions in reflex segments of behavior such as we find in our complex behavior segments, in which the final act is preceded not only by a definite attention set but also by another reaction which we may call a free perceptual or ideational act, and still other sorts of responses.[5] It is the absence of the anticipatory or precurrent responses which justifies the statement that reflexes involve no foresight of the end or knowing by the organism with respect to what is to take place before the response occurs or what is in fact transpiring at the moment of action. But what of the complicated reflex behavior in which apparently several adaptations are taking place? Upon investigation we find as a matter of fact that such behavior can be analyzed into a series of behavior segments; that is to say we can analyze the behavior into a series of stimulus and response coordinations. And here, as is not the case elsewhere, we have a chain effect. One final response serves as the stimulus for the next reaction and so on throughout the series no matter what its length.

From the unitary character of the response in the reflex segment of behavior follows the fact that reflex action is abso-

[5]For a detailed analysis of a reaction system see an article in the Journ. of Philos. 1921, 18, 253.

lutely unintelligent action. And this statement holds true no matter how complexly conditioned is the response act. For the character of intelligence is an essential contribution of the precurrent reaction systems. The latter are means of conditioning actions so that they can serve to adapt the organism in a very precise way to a particular total stimulating circumstance. Needless it is to contrast this prescient type of conditioning of one part of a response by another phase of the reaction, with the simple conditioning of a total reaction by the stimulus, as is the case in reflex behavior. The most complex conditioning of the latter sort, while demonstrating an awareness on the part of the reacting organism, merits in no degree the ascription of intelligence.

As a consequence of the unitary character of the reflex response it appears to possess the following specific characteristics, namely (1) relative automaticity, (2) constancy, (3) permanency, and (4) localizability.

(1) *Relative Automaticity.* Since there is but one immediate movement or one essential secretory act, then the reflex response must perforce appear as practically automatic. An evidence of the automaticity of the reflex is the fact that it occurs and reoccurs in practically the same way no matter what the person is doing at the time or where he is when the stimulus is presented. It is obvious, of course, that when the reflex behavior segment is connected with other segments the total behavior situation of the person may appear different, although the individual reflex act remains the same. Generally speaking we might consider that the mere presence of an adequate stimulus, whether primary or secondary, will throw the reaction system into automatic operation.

It is needless to add perhaps that the automaticity of reflex action is relative in the sense that no psychological reaction can be wholly without spontaneity. What is meant of course is that relative to other responses the reflexes are immediate and direct consequences of the stimulation. There is, in fact, a very close relationship between the stimulus and the response, and no variation through interpolated responses is possible between the appearance of the stimulus object or situation and the final adjustment.

(2) *Constancy.* The constancy of reflex actions is a fact which follows from the function which they perform in the various adaptation situations of the organism or person. Reflex behavior of the simpler sort adapts the person to the simple maintenance situations in which he is found, such as shielding ourselves from immediate noxious stimuli and nourishing ourselves in order to grow. Note that in the trophic reflexes, for example, the mere presence of the food objects at certain strat-

egic points of contact with the organism (at pillar of fauces, for deglutition) brings about the action; also in the shelter reactions, the pin prick, the hot or cold object must be in immediate contact with the organism. Now all of these food and shelter conditions are constant factors in the surroundings of the individual and consequently the reflex adaptations remain constant in their functional and morphological character, although as we have intimated, in the human being reflexes may become organized with other behavior segments. It is possible also that the reaction system as a whole in reflex behavior segments may become slightly modified because of changes in the size and tonicity of the organic apparatus, although the general character of the reaction remains constant.

(3) *Permanency.* Since reflexes are elementary forms of responses adapting the organism to permanent specific conditions they are permanent factors in the reactional equipment of the organism. Moreover, reflex reaction systems do not become integrated and modified to become phases of larger and more complex reaction systems. They remain simple reflexes. We have already indicated that complex reflex adjustments consist of numerous repetitions of a particular reaction system of which the preceding members of the series serve as stimuli to the following ones. In short, a serial reflex is merely a series of behavior segments and not an integration of reflexes into more complex behavior.

(4) *Localization.* The comparative simplicity of reflex reaction systems and the definiteness of their operation permit us to look upon them as partial acts. As a result, it appears as though the organism operates in limited segments when functioning reflexly. Thus we speak of an eye or hand reflex. This partial functioning is not an actual fact, however, for it is a biological and psychological impossibility for the organism to act unless it acts as a whole. When we withdraw our hand from a hot object with which it accidentally comes into contact we obviously react as a complete organism. Similarly every reflex no matter how great a change it produces in the person's relations to his surroundings may be for practical purposes circumscribed and localized in a comparatively limited area.

IV. *The Analysis of a Reflex Reaction System.* Since from our standpoint the reflex reaction system is a typical example of the ordinary unit of psychological activity it would be unnecessary to single it out for analytic description were it not for the fact that reflexes are frequently and always fallaciously presumed to be different in principle from other forms of behavior. To us it hardly seems possible that such a difference should exist and as it is entirely unlikely that any asserted dif-

ference will lie in the glandular, muscular or neural mechanisms involved in reflexes and other action types, we may therefore confine our analysis to what would conventionally be called the mental phases or accompaniments of reflexes.

Let us be understood then, as forthwith declaring that whatever factors are present in psychological responses of whatever description are found also in reflex behavior. And if psychological phenomena may properly be partitioned into cognitive, conative and affective factors, these factors are found in reflexes no less than in any other behavior segments.

(1) And first let us consider the cognitive factor. Every reflex action involves a definite discrimination of stimuli, although the discriminative factor is more pronounced in some reflexes than in others, a condition, however, which reflexes share with all types of psychological behavior. If evidence is needed to prove the presence of a cognitive element in reflexes we need only refer to the fact that in common with all psychological responses, reflexes require their specific adequate stimuli to put them into operation. A hot object will call out the reflex, while a warm object will not produce such an effect. Again, the conditioning of reflex behavior constitutes excellent testimony to its psychological character.[6]

What precisely is cognition then? It is necessary to specify that by cognition we refer to the fact that different objects elicit differential responses from the reacting person or organism. Clearly, in the case of such comparatively simple responses as reflexes the differential reactions will be aroused not so much by complex objects as by simpler qualities of such objects, or in many cases the differential response may be elicited by a condition rather than by any specific quality.

Obviously, we must all agree with those who assert that when we perform a reflex reaction we do not know just what is taking place, for in such a reaction there is lacking the verbal response systems which among other factors strikingly represent the knowing element. This absence of overt knowing, however, in no sense militates against the fact that a reflex action is a differential reaction or a cognitive process. As we are planning to indicate in a later section of this paper, the entire general prejudice against regarding reflexes as psychological processes,

[6]Probably this point does not require much emphasis since we find in a definitely mentalistic textbook the following footnote: "The purely physiological reactions are not absolutely divorced from consciousness. It is a demonstrated fact that mental states may influence or even initiate these physiological activities. The perception of food may start the secretion of saliva. The presence in the mind of certain ideas may affect circulation and respiration—the bated breath, the blush of shame, the pallor of fear, the flush of anger, all testifying to the effect of consciousness upon the purely physiological activities." Breese, Psychology, 1917, 398.

as well as the particular bias against looking upon reflexes as involving cognitive factors, have their roots in the acceptance of an unsatisfactory conception of cognition. This conception implies that knowing is something separated from the adjustmental act. We believe that all difficulties involved in the ascription of cognition to reflex action are dissipated when we recall that by such action we mean in the final analysis an adaptation of the complete organism.

(2) In similar fashion we may find in reflex action an affective factor also. Otherwise stated, an analysis of such behavior reveals a change produced in the organism which we may well call a feeling condition. Glandular and visceral activities are aroused indicating that not only has the stimulus object been acted upon by the organism, but also that the action has extended to itself. Here again it is entirely superfluous to suppose that in any sense the person overtly reports to himself that he feels thus and so; the feeling situation or affective response is merely a sort of internal response involving relatively more the visceral organs than the external skeletal muscles. Naturally the diffusion and intensity of the visceral disturbances will correlate with the violence of the response to the urgency and pressure of the stimulus.

(3) In much the same manner can we analyze in reflexes the conative factor, by which is meant the attention change from one stimulus to another. In no reflex action, of course, is there present the deliberate precurrent change of position or attitude by which the individual prepares himself for adaptation to a new stimulus. Hence, if the term be allowed, the attention factors in all the various reflex action systems are involuntary, that is to say the person exhibits more or less violent jerky movements in shifting his adjustments to new stimuli.

Once more we repeat that throughout this entire analysis of reflex reaction systems we refer to the behavior of psychological organisms or persons. To those of our reactions which are merely biological responses, namely tropisms, and we cannot well doubt that we occasionally perform such behavior, these descriptions which we have offered do not at all apply. In the interests of accurate description we cannot be too careful at this point, for since the psychological organism is obviously a biological organism as well, it consequently is sometimes, albeit very seldom, thrown back upon what we must call biological or tropismic modes of response.

V. *Reflexes Are Not Neural Mechanisms.* If our description and analysis of reflex behavior segments are corresponsive with the facts in the case, then it is manifest that our interpretation of reflex action is in conflict with and must replace the prac-

tically universal belief that these forms of behavior are merely specific forms of neural arcs or circuits. In clearer words, the essential thing about a reflex action is supposed to be a particular concatenation of neurons, usually described as preformed patterns in the nervous system. Probably the most fundamental error in the neural theory of reflexes is that the neural apparatus is in some sense presumed to be the cause of the muscular movement and glandular action which constitute the observable results of the reflex action. In the neuronic theory apparently the neural circuit replaces the soul or consciousness as cause of a given adaptation. Credence is lent this view when we consider that as a matter of historical fact the so-called spinal reflex was sometimes considered to be the exclusive reflex type of action, while at other periods the spinal reflexes were presumed to be the typical if not the exclusive reflex responses.

In addition to the general difficulty which is involved here, of neglecting most of our reflex reactions, for we probably have as many cerebral as spinal reflexes, another question arises equally fundamental for the whole of physiological psychology. Does the neural apparatus control the muscles any more than the muscles and glands control the neural apparatus? Is it not a fact that the specific pathways involved in any reaction are involved because certain muscles or glands need to function? The writer is firm in his disbelief in the functional priority of any system to any other. In fact, to our way of thinking no such priority exists or can exist in the ordinary circumstances of behavior.[7] Especially clear becomes the problem of the supremacy of the neural apparatus when we consider the activities in which the muscle spindles are the primary receptors, for in such activity we have a circular process from which it is extremely difficult to analyze out prior or posterior phases of the reaction. This action in our opinion minimizes the general view of the primacy of the neural apparatus in any type of reflex action.

Is it not closer to fact to affirm that the neural, muscular, glandular as well as all other action phases of any behavior are simultaneous in their functioning and that no system is prior to or more important than any other? What actually happens in every psychological behavior is that the organism performs an act of which all the component systems are phases, in the sense that they constitute factors of a total response. In their aggregate these phases constitute an adaptation to some object or situation. But apparently we have dissipated the cause of the adjustment. What, it is asked, if not the neural

[7] In various experimental procedures we may of course consider either the neural or muscular acts as prior.

apparatus, conditions how the muscles, glands and other phases of the reflex should act?

To this we answer: what in fact could be the cause of which the total (neural, muscular, glandular) adjustment is the effect but the stimulus object or situation, for in general what other observable causes of our actions are evident? Again let us stress that a reflex action represents a differential mode of behavior, neural, muscular, glandular, etc., which the organism has acquired in the course of its development and which now operates when its adequate stimulus is presented. The failure of reflex descriptions is largely owing to the fact that psychologists do not recognize the dependence of reflex action upon actual stimulation, exactly as is the case in any other psychological action. When we do appreciate the relationship between the stimulus and the total unitary response then we can cheerfully dispense with the causative character of the neural apparatus.

Now here another objection may be anticipated. How can we argue that the neural factor is not primary in importance nor prior in time when we know that as a matter of fact the essentially conductive function of the neural apparatus requires some time to operate, no matter how brief? Such an argument, we reply, rests upon a misconception which can be obviated by a closer observation of facts. Of a surety when we experiment upon a neuro-muscular coordination we may with perfect propriety disengage logically the conducting from the contracting mechanism, but when we do perform such a logical analysis we must not forget that such an experiment implies the falsism that the mechanisms are both inactive at the inception of the experiment, when in fact both nervous and muscular mechanisms are functioning before the experiment is started, since the organism is never at rest. Further, this objection implies that a single neural impulse can be in fact isolated and that it can be traced from a receptor to a muscle or gland. Now it is incontrovertible that a psychological organism is constantly in action and therefore neural impulses are discharging uninterruptedly over all the tracts in synchronous harmony with muscular, glandular and other types of processes. What in actuality happens when we present the organism with a stimulus is a redistribution of action, an emphasis of other features of the person than were prominent when the new stimulus appeared, in short there is a refocussing of the individual upon a new stimulus.

By way of emphasizing our hypothesis that if a reflex action is a psychological datum it is a segment of behavior, i. e., a stimulus and a response, we mean to deny as stated before that a reflex is a partial reaction in any sense. In especial, we mean to controvert the three typical forms of the decurtation theory

concerning reflexes which are found in psychological and physiological literature. (1) Reflexes are not primarily neural circuits in the sense of concatenated neurons or the operation of such circuits. (2) Neither are they exclusively activities of the complete nervous system. (3) Nor are they merely neuromuscular or neuroglandular responses. Again, we return to the charge: reflexes are complete or organismic adaptations to specific or adequate stimulating objects and circumstances.

Lethal is the blow dealt to all neuronic abstractions by the fundamental facts of neural physiology. No question exists at all but that the nervous system functions as a unified whole,[8] and while the neural abstraction may be useful for experimental purposes, as our quotations from Sherrington indicate, physiologists and neurologists are not insensitive to the factitious character of the neural circuits. To the writer it appears most extraordinary that psychologists who are not benefited in the slightest by neural abstractions but on the contrary are seriously hampered by them in their studies, still persist in their employment, whereas even the physiologist uses them only as convenient fictions.[9]

From the experimental work on neural physiology we believe that we derive substantial support for our organismic view of reflexes. What do we learn from spinal and decerebrate animals? Certainly not that organisms can function in parts. On the contrary, what we learn from laboratory animals is that a truncated organism can perform comparatively simple activities. This fact is amply demonstrated in the classic descriptions of Flourens, Bouillaud, Schrader, and others[10], when we forget their futile arguments about "consciousness" and its seat. Especially well brought out is this fact of truncated action in Munk's distinction between sensorial and psychic blindness.[11] It is because animals are simpler in their organization that the vivisectional experiments can be performed upon them without destroying entirely their capacity to act. By no means must we believe that a transsection or extirpation indicates that the animal can function in parts because some of its behavior is mental and some merely neural. No, the fact is that experiments can only be made up to the point of not disturbing the intrinsic functional organization of the animal. For this reason, exper-

[8]Cf. Sherrington, op. cit., 114; Herrick, An Introduction to Neurology, 1920, 60, 69, and elsewhere.

[9]It is not unfair to say, then, that the neuronic theory of reflexes is not even a physiological but a histological hypothesis.

[10]For an excellent general summary of this work, see Luciani, Human Physiology, 1915, vol. 3.

[11]Luciani, op. cit., 599. Is not the difference between a sensorial and psychic reaction merely a variation in degree of adaptational complexity?

iments on the higher apes or the human being produce either "shock" or death. But as long as the functional organization of the animal remains undisturbed throughout all the mutilations it is as much a psychological organism as it ever was. No other view would ever have been held but for the assumption by most workers that consciousness was a force or power separate from, but paralleling exclusively, the cerebral functions, or was coordinate with other neural functions, as Pflüger, Goltz, and Lewes believed.

We find in the reflex controversy,[12] as well as in the facts which the contending parties sought to interpret, considerable evidence for our contention concerning the unitary character of psychological behavior. Both the mechanical and spontaneity arguments are of course partial views, as the facts employed in them amply testify, and are not nearly as much descriptions of those facts as they are metaphysical interpretations. Both views are frankly based upon a psychoneural dualism, the existence of which we unqualifiedly deny. That the organismic theory is sound may be further seen from the fact that in the human organism much reconstitution and substitution of behavior may occur during and because of the degeneration of cortical tissue,[13] although the extreme intensity of the general functional organization is such that few liberties can be taken with the individual because of destroying the animal's organization.[14]

VI. *The Origin of Reflex Behavior.* From the standpoint of genesis, reflex responses are unique among the permanent behavior equipment of human beings, in that they may be considered as the earliest and most intrinsic of all the types of responses. The simplest of them are organized and operate considerably before the completion of gestation. Exactly does this fact comport with the function and general behavior conditions of these comparatively simple but utterly essential activities. Reflex behavior is essentially life-maintaining activity and therefore is most intimately related to and dependent

[12]Cf. Lewes, The Physical Basis of Mind, 1895, Problem IV.

[13]Franz, Cerebral-Mental Relations, Psychological Review, 1921, 28, 81; Variations in Distribution of Motor Centers, Psychological Review, Monograph Series, 19, No. 1; Brown and Sherrington, Note on the Function of the Cortex Cerebri, Proc. Physiol. Soc., Mar. 15, 1913; Journ. of Physiol., 1913, 46, xxii.

[14]Excellently illustrated is the highly integrative character of the human responses by the phenomena which Head and Riddoch (Brain, 1917, 40, 188-263, 264-402) have called mass reflexes. It appears that when the human cord is transsected the reflex responses of the individual which are found after the shock subsides are greatly reduced in functional complexity and effectiveness. Naturally we cannot agree with Rivers (Instinct and Unconscious, 1920, 28) that these reflexes are "suppressed" actions.

upon the biological structures of organisms. Hence, reflexes absolutely must begin to operate from the very inception of the organism's life; in fact the reflex reaction systems may be said to be inherited (if this can be said of any response system) along with the specific organs which have a part in their operation. So elementary and primary are some of the simple reflex responses that as a general rule the impression is prevalent that all reflex reactions are congenital and that none of them are acquired in the life of the person. Such an assumption is not strictly correct. To account for the essentially adaptive character of such basic and undeveloped reactions which are not inappropriately named protective, defensive, avoiding, and seeking responses, we must fall back upon some sort of natural selection hypothesis.

Need we add that neither the mode of origin of reflexes nor their essential features of permanency and constancy deprive such responses of any specific psychological character? Let it be noted that the psychological domain comprises behavior covering wide ranges of complexity and effectiveness, but significant is the point that all these types of reactions are determinate responses to stimuli, whether the adaptation involved be complex and imply much previous contact with its stimulus or whether the reaction be fairly simple and occur while the organism is in primary contact with the stimulus calling out the act in question.

It is possible that the basic character and primitive origin of the reflex responses contribute no small share to the constancy and permanency of these reactions. That is to say, as long as the type of organism remains unmodified and as long as the reciprocal stimulating circumstances remain the same, then there is no need for the variation in the response system.

VII. *Distinction Between Human and Animal Reflexes.* Because of the comparative simplicity of reflex action it is doubtless true that the slightest variation exists between human and infrahuman behavior at this point. And yet if we were to overlook the enormous differences that after all exist between human and animal reflexes we should do irreparable damage to our observations as well as our interpretations. For there are great differences even between the various reflex actions of the human individual, depending upon size, weight, health, and maturity, which cannot be neglected in any analysis of behavior, especially if we are to attain exactitude in our descriptions. From the existence of the different reflexes in the human species it follows that there must be extreme variations in the behavior of the individuals of the human and infrahuman developments.

In support of the proposition of the wide variation between human and infrahuman reflexes two sorts of considerations

suggest themselves. First, not only the general biological differences between the two species of animals but also the specific neural disparity argue conclusively for great diversities between the two types of reflexes. The second and more striking consideration is the general fact of behavior equipment. If our hypothesis is valid that a reflex act is a specific type of organismic adaptation, then clearly the behavior must be colored by the total reactional condition of the individual. In other words, the reflex action in the human being must be a function of the entire behavior equipment of the person[15], and the specific surrounding circumstances. Now obviously the behavior equipment of the person is so different from that of any infrahuman animal that the reflex behavior as well as any other class of action will be very different in the two cases.

Whatever argument is offered for the continuity of the two series of reflexes must perforce be based upon continuity in biological development. Now such continuity, it must be observed, does not imply any similarity in specific acts of psychological behavior; rather the argument for continuity overlooks all actual facts of concrete behavior in favor of a general developmental or descent hypothesis. Such a neglect of the specific adjustment inevitably results in error. To illustrate, it was only because of a lack of interest in actual adjustments that the believers in continuity attempted to make of spinal reflexes the typical reflex action to the exclusion of cerebral reflexes, and moreover, they believed this in disregard of the fact that even when reflexes are considered as neural mechanisms they are cortically controlled and modified.[16] In view of the cortical control of reflex action who can deny the distinction between reflexes which we are attempting to make? In concluding this section of our paper we might suggest that our distinction between human and infrahuman reflexes in no wise interferes with the biological continuity doctrine. For the logical implication of our hypothesis is that only a degree of difference exists between any two levels of psychological action. In consequence, it is our argument that animals are not different from human beings in lacking memory, thought and language, as the textbooks would have it, but only in the capacity to respond with simpler memory, thought and language reactions. But note, that in all cases of behavior the needs of psychology dictate a careful and accurate differentiation and description of responses.

[15]How potent is the behavior equipment of the organism in influencing its actions may be well observed in the illustration which Whitman quotes of the pigeon reared by a wholly different species which will reject a mate from its own species in favor of the species under which it was reared. Cf. Orthogenic Evolution in Pigeons, vol. 3, The Behavior of Pigeons, 1919, 28, edited by Harvey Carr.

[16]Cf. Herrick, Introduction to Neurology, 1920, 68, 120, 312.

VIII. *Types of Reflex Action.* For practical purposes we might classify reflex reaction systems into at least five types, partially upon the basis of their organization and especially upon the kind of contact which they effect with their ordinary stimuli. In general, reflexes may be adjustments to conditions (1) within the organism, or (2) to changes surrounding the individual or (3) to both of these at once. The first type we may name the interoceptive reflexes and we may mention as illustrations of such responses the stomach and intestinal reflexes, etc., or expressed differently, responses in which these phases of the organism play a prominent part.

On the other hand, reflexes which are primarily adjustors of the person to outside stimuli we may call exteroceptive actions. Here we may analyze two types which we will name localized and general exteroceptive reflexes respectively. In the former type the response appears to be localized in a definite way and involves primarily external skeletal mechanisms. As examples of these reflex actions we may name the hand, foot or body withdrawal responses to heat or pain objects, the knee jerk, turning the head toward a flash or sound, etc. The latter type, i. e. general reflexes, contrasts with the local responses in that a larger phase of the organism is saliently involved and also in the fact that the visceral and glandular factors may dominate the segment of behavior. As examples of the general exteroceptive reflexes we may quote writhing, trembling, shivering, etc.

The third class of reflex which adapts the individual to both external and internal stimuli we will call combination reflexes; these we may likewise analyze into two types, local and general. The former type would comprise adjustments of a more or less restricted sort, although on the whole the reactions would be more complex than those in our second class. Among the localized combination reflexes we may enumerate the sexual and salivary responses. In this class both the local and general responses may involve much glandular activity although the latter involves so much more of the visceral and glandular factors that we may refer to some of them at least as feeling reflexes. Illustrative of the general combination reflexes are the "startle" and "start" responses which are frequently confused with feeling and emotion reactions, and which in some cases constitute the simplest form of attention acts.

It is plain, of course, as we have indeed suggested, that the specific reaction systems in these different types of reflexes will be integrated from specific factors. For example, the principal interoceptive reflexes as a rule will include mainly both muscle and glandular factors while the exteroceptive reflexes involve primarily the skeletal muscles. Again, practically all

the interoceptive and some of the exteroceptive reactions will involve the sympathetic nervous apparatus in a prominent way, while the exteroceptive reactions will involve mainly the central nervous system. A prominent exception to this rule is the iris reflex in which the muscles involved are innervated by the sympathetic system. In such comparatively simple reactions as reflexes the discriminating factors would naturally be, as we have already seen, the simplest found in any reaction. In all of these cases, to be sure, the discriminating factor strictly speaking is nothing more than the occurrence of a simple differential response to its specific stimulus-object. As in all cases of classifying reactions the divisions and subdivisions that we have made represent only attempts to order behavior and not the separation of unequivocally different responses. For this reason no classification can avoid many overlappings and the value of any classification may be judged most adequately by the criterion of whether it suggests the likenesses and overlappings of behavior types or whether it serves to obscure such similarities and transcursions of the classes.

IX. *The Stimulation and Conditioning of Reflex Action.* A radical change in the view concerning what constitutes the stimulus for reflexes is implied in the acceptance of the organismic hypothesis. For if we assent to the view that reflexes are adjustments of the individual some of which are very complex, then we can no longer entertain the notion that they are aroused to action by merely simple thermal, light or sound radiation. Aside from the general confusion which this notion implies between the media of stimulations and stimuli objects or situations,[17] such a view in the domain of reflexes excludes all but the simplest situations as stimuli.

Let us notice then that reflex action is stimulated as are all other kinds of responses by objects of various sorts, and by circumstances and situations. To be plainer, human reflex actions are rapid and localized responses to things, persons, and conditions. Now this way of describing the reflex situation allows for the fact that the whole person is acting and not a single part of him, which is of course an impossibility. Moreover, this mode of analysis forestalls the tendency to overlook any type of reflex response, since we may be entirely certain that the class of reflex action is large enough to include more than the very simplest avoidance responses. How complex and varied the stimuli for reflex actions actually are appears clearly in the consideration that objects in particular settings will elicit

[17]For a distinction between stimuli and their media, cf. Kantor, A Tentative Analysis of the Primary Data of Psychology, Journ. of Phil., 1921, 18, 257.

the salivary reflexes while the same objects in different settings or different objects in the same settings will not bring out the reflex adjustment. What more complex stimulus can there be than the actions which operate while we are reflecting upon or reading of some person or event which excites us to sex or hunger functioning? Extremely informing also are the observations concerning the reflex changes in the person while under the subtle social and sex stimulation of other persons. Especially important here are the complex social objects and situations which constitute the stimuli for intricate human reflexes of all sorts. As among such social situations we may refer to games and gatherings of persons of the same or opposite sex which arouse sex and hunger responses of various degrees of diffusion. Again, we are familiar with the revulsion responses which dead or live animals produce in us when touched or seen; these are all complex reflex responses representing functions of the total reaction equipment of the person to customary stimuli which are therefore social in nature.

In the last mentioned reflex adjustment as well as in many others we meet with the very important conditioning activities influencing the adaptation of the person to his surroundings. Thus, for example, the nauseous visceral responses to dead animals may have become definitely attached to this new or accessory stimulus at some specific time and under particular circumstances. The early stages in training an infant to perform proper excretory behavior is in great part a process of attaching reflexes already present and functioning to a new eliciting stimulus.[18] Especially subject to the conditioning process are the combination reflexes, since the internally stimulated act can be variously transferred to and from the coordinately stimulating external object. So involved are the conditioning processes that in many cases it truly appears that the reflexes have become integrated into more complex forms of behavior, although as a matter of fact this type of response remains practically in its original condition throughout all of its complication by attachment to various new forms of stimuli.

X. *Reflex Action as Stimuli and as Behavior Setting.* So intimately related are the reflexes with the total behavior of the organism that they constitute the stimuli to many of our reactions. Because of this intimate relation, however, the reflexes are frequently overlooked and their importance unsuspected. As a consequence psychologists are frequently guilty of the assumption that mysterious powers bring about various reactions, whereas a careful study reveals that the reactions in

[18]This conditioning process may antedate the development of the necessary inhibitions.

question have definite stimuli in the reflex responses. There can be little doubt that reflex stimulation is responsible for much of our action which we call diffuse feeling-responses and moods and that they compose elements in our complex social acts; acts of love, pity, revenge, etc. may be due in large measure to reflex stimulation.

To state it otherwise, the reflex stimulations comprise some of the facts referred to as mixed motives in complex responses. Can we deny that it is through the accessory stimulation of reflexes, in addition to thoughts and memories aroused by tales of cruelty and violence, that we are induced to add our contribution to alleviate the suffering of which the stories inform us? In further illustration of reflex stimulation we may quote the ways in which our reflex responses color our reactions to aesthetic objects. Thus through the operation of these by-play reflex reactions we are stimulated to read human and personal qualities into physical objects stimulating us. In many instances the additional stimulation by reflexes may also supply energy and alacrity to the behavior. This latter fact has been celebrated in the statement that artistic production is the sublimation of sex impulses. While the term sublimation hardly represents a psychological process, still it does serve to emphasize the prevalence and power of reflex stimulation. In all these cases, reflexes serve as adjunct or additional stimuli and as a result of their operation the individual may act in an entirely different way than if he were stimulated only by the original object. Suggestive it is to note that the way we respond reflexly to things and persons in turn stimulates our first impression reactions to those things and persons. In other words, reflexes of a complex sort are called out in us by things and people and then when we attempt to formulate a judgment of these things and people, or if we merely are prepared for some future response, the delayed action is based and dependent upon reflex responses.

Furthermore, reflexes may function as combination stimuli-responses in delayed reactions, which function in general is made possible by the fact that series of reflex responses intervene between the presentation of the stimulus and the final adjustment, and thus function in many cases to keep alive the effect of the stimulation until the final response occurs. The combination reflex act-stimulus is undoubtedly a primary basis of the wants and desires as psychological facts. One is forcibly led to this view by the consideration of the place of sexual and hunger-digestive reflexes in food and sex wants and desires. So potent are the reflex actions as stimuli, that we can elicit from a careful study of the differential frequency and intensity of such reactions much valuable information concerning the type differences between individuals which are usually consid-

ered as temperament, disposition, etc.; such characteristics being marked by actions which in a large measure are stimulated by reflex responses.

And finally, the visceral and glandular reflex behavior of persons may serve not as direct stimuli to actions but rather as the setting of responses. That is to say, these reflex responses serve as influences of behavior affecting the general condition of the person. As the setting of stimuli, visceral reflexes determine whether or not certain stimuli shall be potent and call out a reaction. Thus for example, during the operation of hunger reflexes it is more difficult than otherwise to attend to one's work; in other words, the sensitivity to exacting stimuli is decreased; in other cases the functioning of reflexes may serve to increase one's sensitivity to particular stimuli and in consequence the person will respond more readily to surrounding objects.

XI. *Reflex Action and Instinctive Behavior.* Very prevalent is the view that reflex actions are closely related to instinctive behavior and especially is this assumption made in order to provide a solid foundation for instincts. In detail, instincts are presumed to be combinations or chains of reflexes, and since the latter are supposed to be specific neural pathways the conventionally teleological instinct achieves a factual support. From our standpoint, however, the relationship requires reformulation, since we cannot assign to instincts any sort of teleological character nor can we consider reflexes to be merely neural mechanisms.

Instinctive actions we consider to be behavior segments of a different order and type than those of reflexes and the main difference is that the instinctive behavior segments contain more than one reaction system.[19] Common to both instincts and reflexes, however, is the fact that both acts constitute definite final adjustments although an instinct segment of behavior contains a pattern of several reaction systems. Because the instinct segment of behavior does contain more than a single reaction system, it partakes of a series of definite characteristics not found in the reflex segments. These characteristics we may enumerate as follows: (1) spontaneity and variability, (2) modifiability, and (3) integration.

(1) By spontaneity and variability we mean to refer to the greater adaptability which instinctive behavior exhibits than do reflexes. The latter may be conditioned in various ways; that is to say, the simpler reaction system can be differently attached to a stimulus, but the response factor itself does not vary. In

[19]Unquestionably the fact that these reaction systems are morphologically exactly like those of reflexes constitutes the factual basis for saying that instincts are chains of reflexes.

the case of the instinctive reaction on the contrary, the members of the pattern may rearrange themselves in modification of the pattern.

This arrangement is made possible by the fact that while the total pattern may be stimulated by a definite appropriate stimulus, say some interoceptive reflex, the individual reaction systems in the pattern are aroused to action by other surrounding stimuli, namely, objects and conditions; so that each has some autonomy and the whole pattern is spontaneous. Accordingly, the instinctive behavior act is the more adaptable response when the adjustment conditions are more variable. This type of instinctive adjustment in which the member reaction systems are subject to rearrangement is the most spontaneous that we can observe. The reactions which are less spontaneous are so because the member reaction systems of the segment are only very little stimulated by the surroundings and more by the preceding members of the pattern series. It was this kind of instinct, no doubt, which gave rise to the notion that instincts are chains of reflexes. When there is only one, or at most only a few surrounding stimuli conditioning the instinctive behavior, then the reaction as a whole will be more rigid and conform to a type.

(2) Since the individual reaction systems in an instinct behavior segment are correlated with specific external stimuli it is entirely probable that the auxiliary stimuli may become more and more effective as factors in the total response, thus modifying in a specific way the total instinct act and making it more serviceable to the organism in its particular surroundings. This modifiability contrasts with the permanence of the reflex behavior segment which cannot of course be modified in any essential degree.

(3) Another intrinsic characteristic of instinct acts is the fact that when conditions allow and make necessary they become integrated into more complex reactions. It is this fact of integration above all which marks off the human from the infrahuman instinctive behavior and also distinctly differentiates instincts from reflexes. While the reflex activities remain practically as they originally appear, instinct behavior becomes developed into more complex forms of responses. And so it happens that in the animal domain the instinct reactions become integrated to only a slight degree because the conditions are not conducive to any considerable development. In the human individual on the other hand, the behavior conditions are so complex that there are very few instinct responses to begin with and these few become integrated into larger reactions and disappear. By the same token the reflexes which originally comprise

elements in the behavior equipment of the individual remain with him in practically the original number and condition. We might repeat here once more that reflexes become modified only by conditioning, that is to say, the correlated stimuli may vary and consequently the whole behavior segment becomes altered but not the response factor or reaction system itself. It is consequently clear that in our comparison of reflexes with instincts, animal instincts must be understood to be the facts discussed, while in the case of reflexes both animal and human actions may be considered as the subject matter in question.

Superfluous it would seem now to add that in our entire discussion we referred not in a single sentence to instincts in the sense of a purpose or impulse in the individual to do various kinds of acts; no such impulses, we firmly believe, exist in any sense.[20] Many times we have implied that we are discussing only action mechanisms which are constituted exclusively of definite adjustment acts conditioned by stimulating circumstances with which they are coordinated.

XII. *Reflexes and Tropismic Action.* As a final consideration of reflex action we may place it in comparison with tropismic or purely biological action. Since there is no strict convention governing the use of the term tropism, let us be understood to exclude the criterion, that such action does not involve systematized nervous tissue. For our hypothesis concerning the adjustments of organisms does not permit us to seek in the mechanisms of organisms for the exclusive conditions of behavior. Now observe that very prominently is the comparatively simple mechanism of the tropismic action correlated with the sensitivity of the organism to its surroundings. As a matter of fact it is possible to differentiate between reflex actions as typical psychological responses, and tropisms, on the basis of the relationship of the organisms to the surroundings when they are performing either one or the other type of action.

Although it is entirely probable that the difference between tropisms and reflexes is merely a variation in developmental complexity, still we can specify particular adjustmental differences. For example, tropisms as responses, while entirely disproportional to the exciting condition in the expenditure of energy, in form and type of movement are still constant. This constancy of movement is a function of

[20]But this is no sufficient reason, however, for doing away with the name instincts as some recent discussions of instincts seem to imply, since we believe the term may reasonably be used to symbolize some definite form of psychological phenomena.

definite organic structures operating as a whole in the manner which is referred to as irritability, and correlates exactly with some stimulating condition in the surroundings. This external condition is practically an undifferentiated condition and never an object with its specific qualities. Moreover, the reactions are such as maintain the present status and condition of the individual's organization exclusively by means of metabolic functioning. From this standpoint it is easy to see why we must look upon tropismic action as relatively simple responses to surrounding conditions.

Reflexes as psychological activities, on the other hand, are specific responses to particular objects and conditions. Such behavior, as we have seen, constitutes differential responses and exhibits a subtle interdependence of stimuli and responses. By virtue of the person's possession of numerous characteristically different reflex action systems to which many different specific objects and conditions are coordinate, the individual is selectively sensitive to many features of the *milieu*. That this essential psychological character of reflex actions has been overlooked may be accounted for by the fact that many of the specific differences between reflexes and tropisms seem to fall away when we compare them both with the higher developed and more complex adaptations which we may call volitional responses. Such an overlooking of the definite psychological character of reflex action is exceedingly unfortunate, of course, since as a matter of fact reflex responses can be shown to partake in some fashion of practically all the typical characteristics of the complex psychological reactions.

XIII. *Conclusion.* In conclusion, we might suggest that our study of reflex action finds its most important feature in the general psychological problem which it raises. How shall we look upon psychological phenomena? Shall we consider them as definite autonomous facts in nature or shall we look upon them as merely epiphenomenal attachments to such facts? Or, again, shall we try to make psychological facts into physiological actions, because presumably psychological activities are not concrete or simple enough to handle without changing them into neural terms? In our study the conclusion we reach is that unless we consider reflexes as well as every other type of reaction as definite psychological facts, and not physiological acts, we cannot hope to understand them. That psychological acts are just as definite and just as real as any other kind of fact investigation has amply revealed. A definite criterion for a psychological fact we have discovered in the intricate interconnection between a stimulus and a total reaction of an organism.

Applying this criterion to reflexes we have found that such behavior must be considered as definite psychological phenomena, and further, we find that to study reflex actions as definite psychological facts not only enables us better to understand them but to appreciate the place they take in the adaptations of the organism, both as responses to specific stimuli and their settings, and as themselves stimuli and reactional backgrounds for our more complex behavior.